Upper Level Analysis/Forecasting

Why we look at the upper levels...

- ✓ Practically all weather we experience occurs in the troposphere.
- ✓ Data from levels other than the surface is needed to provide the most complete 3-D distributions of winds and temperature in the atmosphere.

The atmosphere...

- ✓ We generally think of the atmosphere in terms of being gaseous.
- ✓ It reacts in many ways similar to that of a fluid.

Standard Levels...

Pressure Level	Meters	Feet
1000	110	370
850	1460	4780
700	3010	9880
500	5570	18280
300	9160	30050
200	11790	38660

850 mb

- ✓ Locate frontal positions
- ✓ Determine representiveness of surface winds
- ✓ Determine depth of moisture patterns in the winter
- ✓ Serve as surface charts in mountainous and plateau area where mean elevation is around 5000 ft.

700 mb

- ✓ Determine vertical extent and structure of fronts and pressure centers
- ✓ Analysis moisture patterns in the summer (moisture extends to greater height due to convective activity)
- ✓ Short waves are a predominate feature

500 mb

- ✓ Primary features are warm highs and cold lows.
- ✓ Long waves are identified at this level, but short waves have lost their identity.
- ✓ It represents the mean state of the atmosphere.

300 mb

- ✓ Primary features are permanent and semi-permanent highs and low, certain dynamic lows, long waves, and polar jet stream in the winter.
- ✓ Primary uses to determine characteristics of long waves and analyzing/forecasting jet stream.

200 mb

- ✓ Uses are same as the 300 mb.
- ✓ Used to locate the polar front jet in the summer.
- ✓ In the winter, its principal use is estimating changes in temperature advection pattern in the stratosphere.

The Jetstream

- A band or belt of strong winds of 50 kts or more with a westerly component.
- At times it is a continuous band, more often it is broken up into several discontinuous segments.
- Generally labeled as the polar front and subtropical jet (and the controversial Arctic or Polar Night jet).

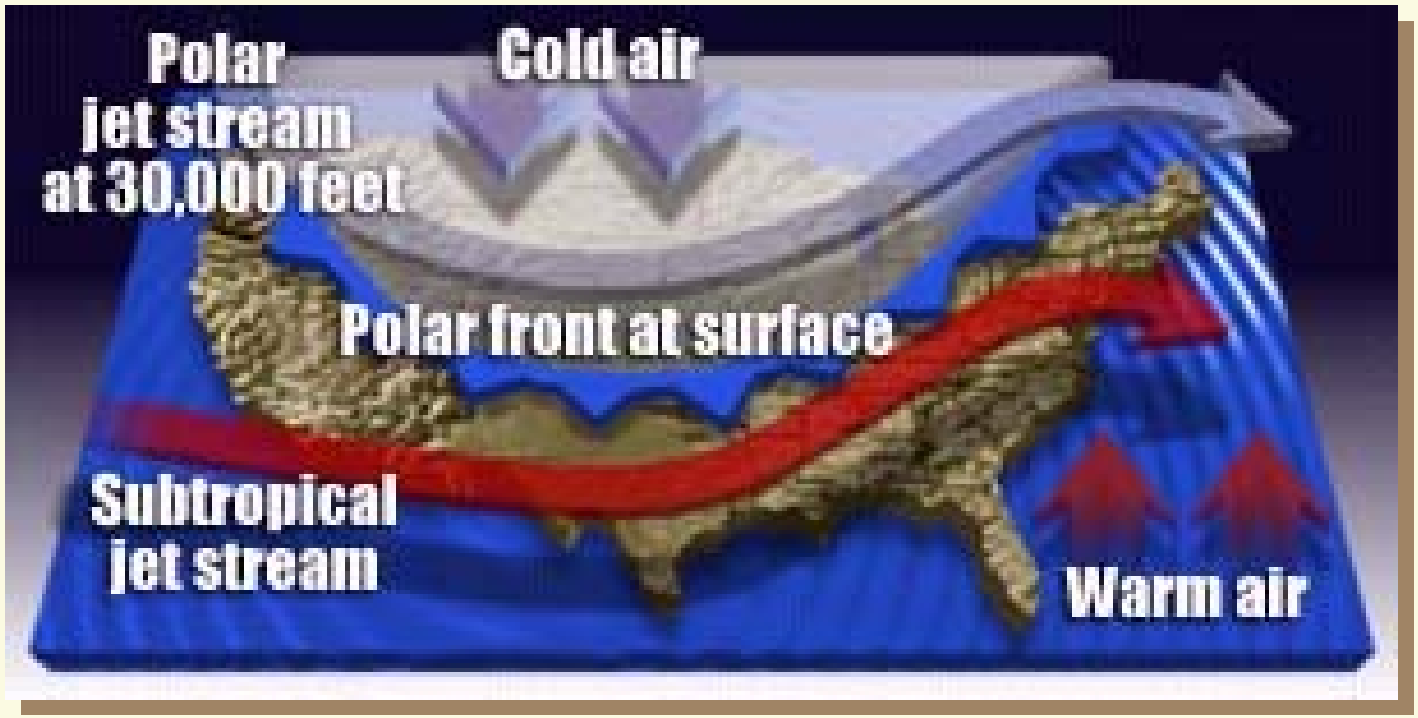
Polar Front Jet

- ✓ Associated with the principal frontal zones and cyclones of middle and sub-polar latitudes.
- ✓ The PFJ lies vertically above the max temperature gradient of the middle troposphere.
- ✓ The PFJ axis at 500 mb coincide with the -17 deg C isotherm (STJ with -11 deg C isotherm).

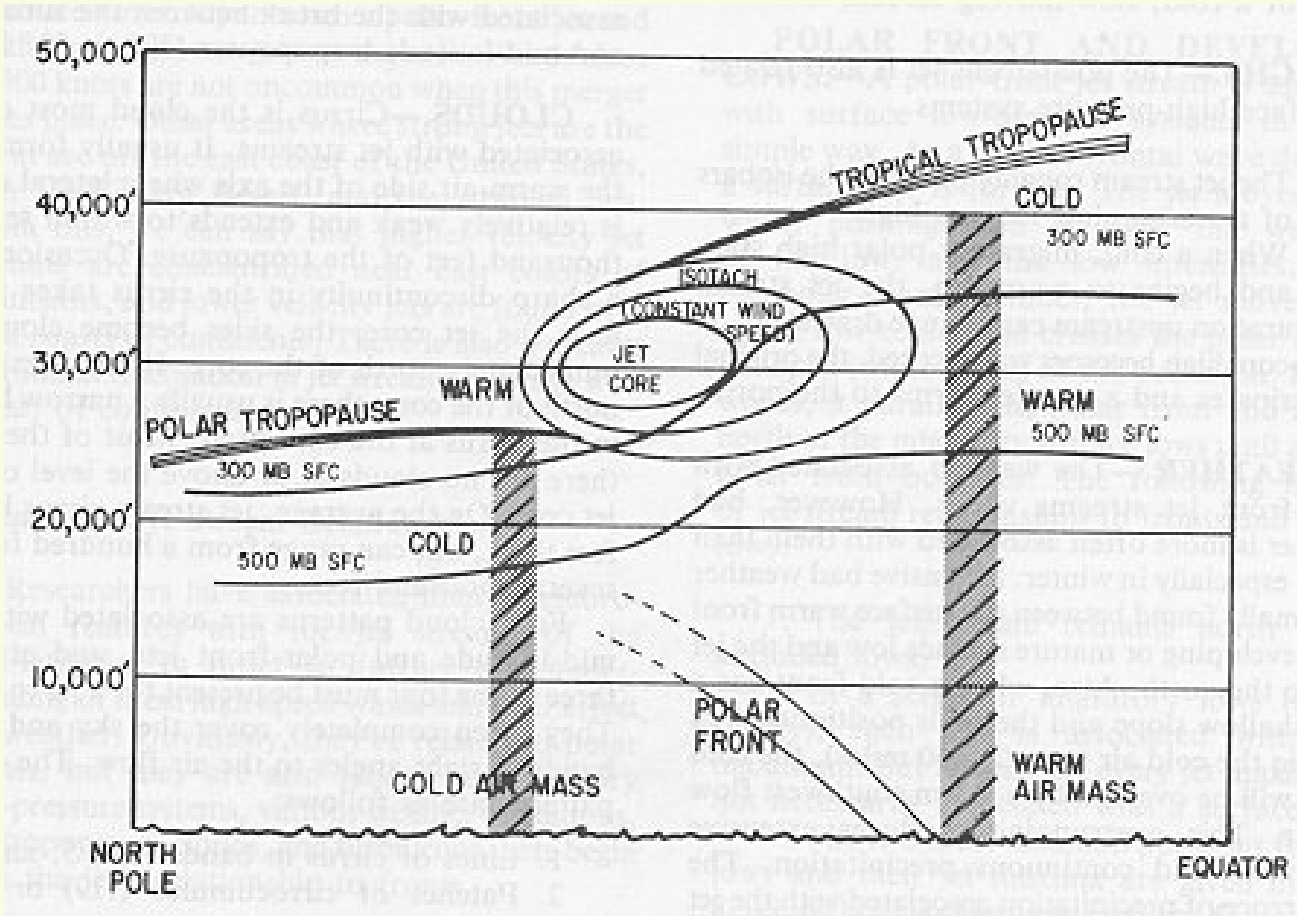
Thermal Field around the Jet

- The core of the Jetstream is located directly above, or nearly so, the thermal concentration of the 500 mb surface.
- The jet core will live between 200 and 300 millibars directly above the strongest meridional temperature gradient at 500 mb.

Jetstreams and Fronts



Vertical cross section of Jetstream



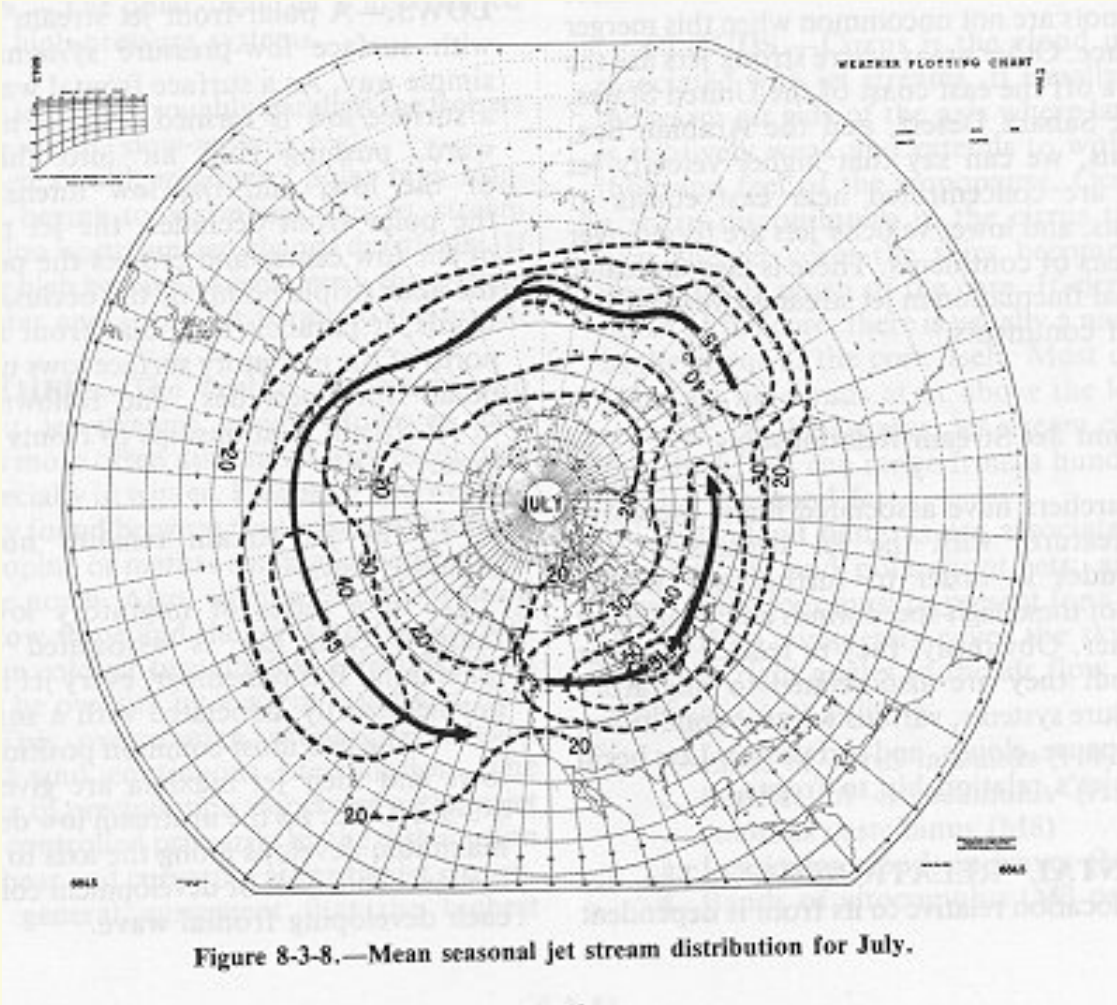


Figure 8-3-8.—Mean seasonal jet stream distribution for July.

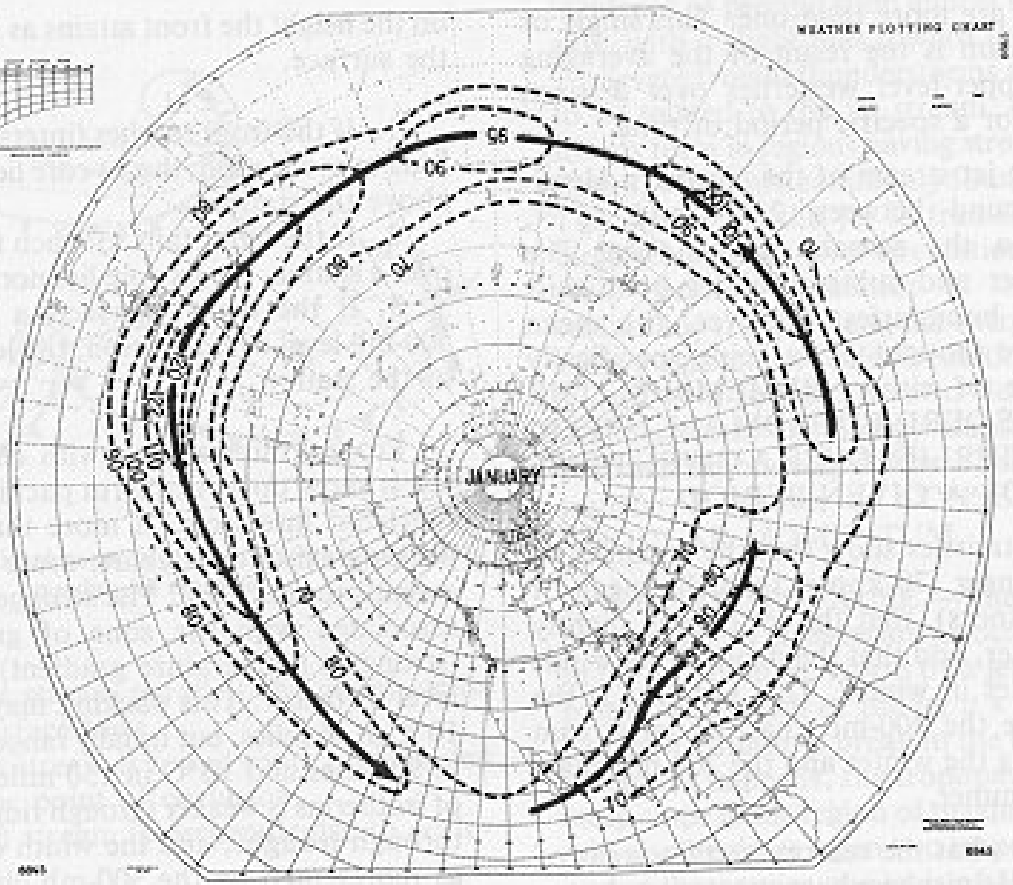
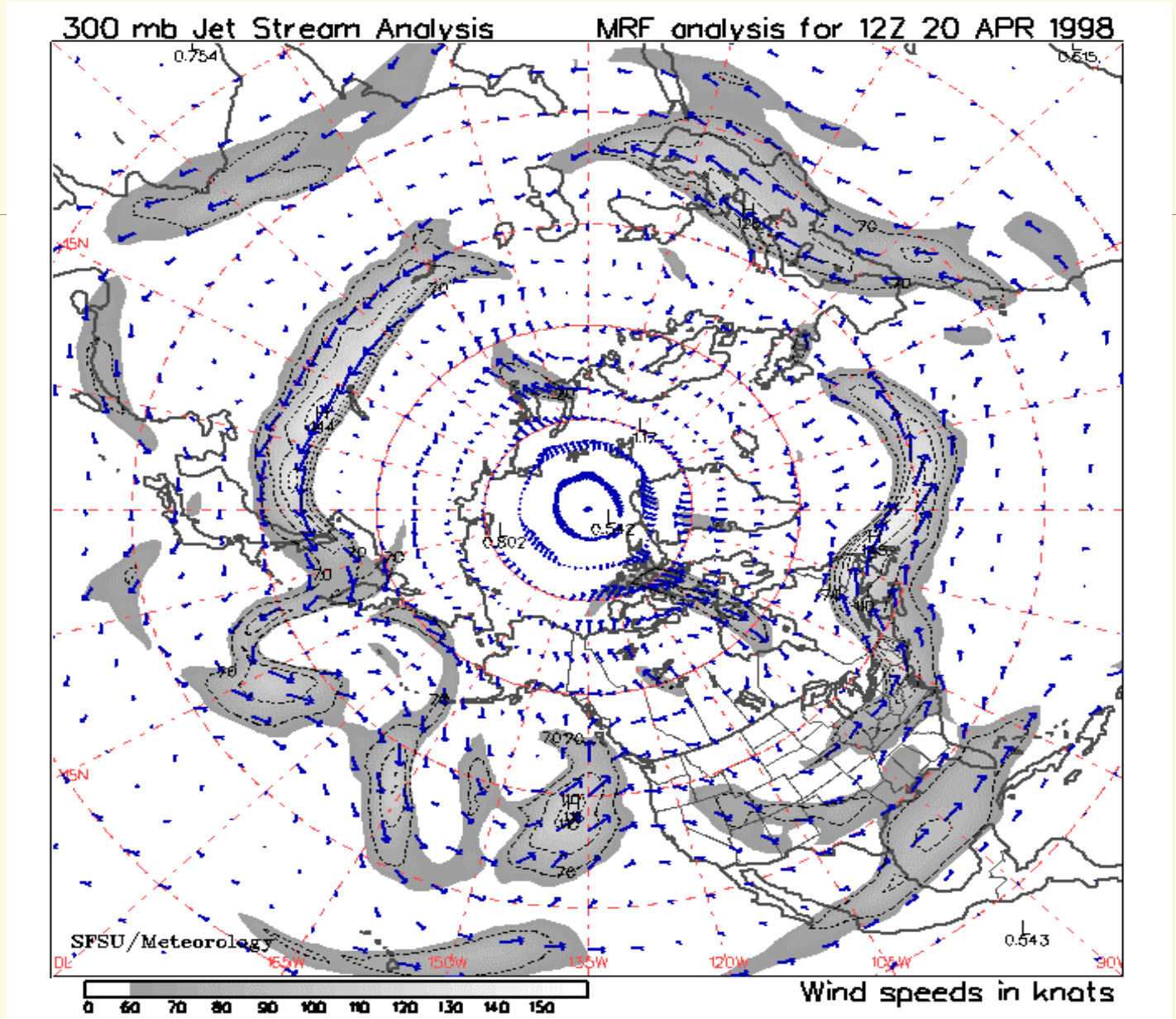


Figure 8-3-7.—Mean seasonal jet stream distribution for January.


300 mb Jet Stream Analysis
MRF analysis for 12Z 20 APR 1998
0.754
0.615
45N
15N
0.502
0.543
SFSU/Meteorology
0 60 70 80 90 100 110 120 130 140 150
Wind speeds in knots

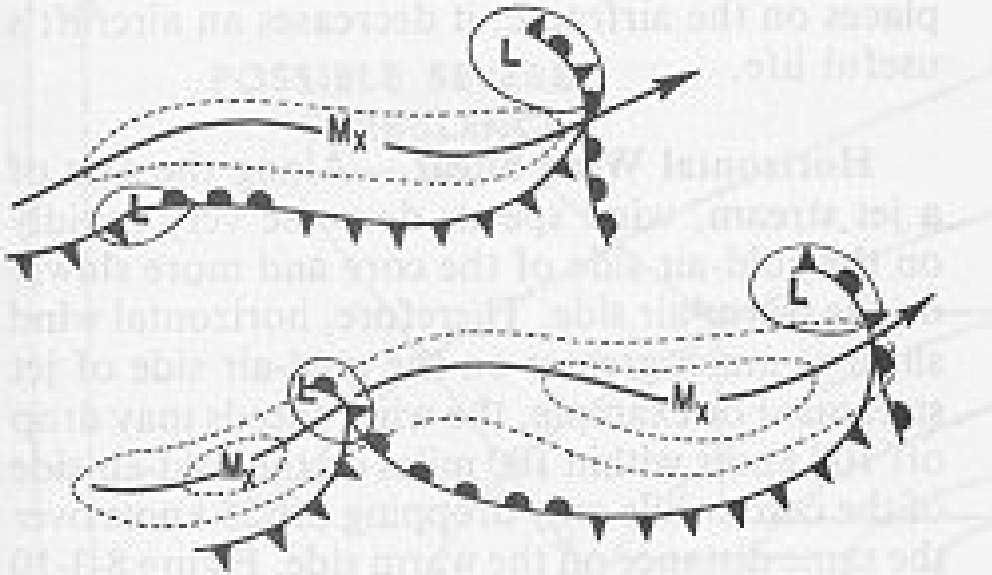
PFJ and Surface Front Relationship

- ✓ The jetstream will be perpendicular to an occlusion and to cold fronts oriented north-south with no associated warm fronts.
- ✓ The jetstream will remain north of an unoccluded wave.
- ✓ The jetstream will be south of the low associated with an occluded front.
- ✓ In a series of lows of a cyclone family each low will be associated with a jetstream maximum, but every jet maximum is not necessarily associated with a low.

Relationship of PFJ to surface lows/front

- ✓ Although not every jet max will have an associated low, each low embedded in the westerlies will be associated with a jet max.
- ✓ The jetstream should parallel the direction of the warm sector isobars of a surface low.
- ✓ The jetstream will roughly parallel the isobars around the southern periphery of a cold surface low.

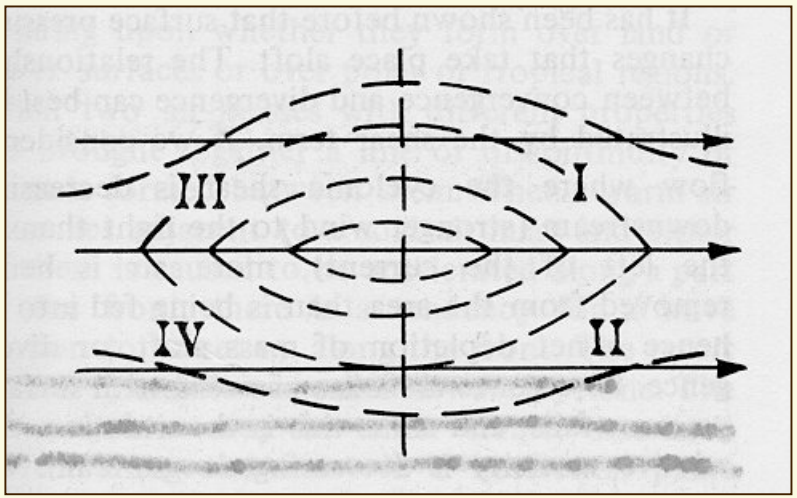
Relationship of PFJ to surface lows/front



209.433

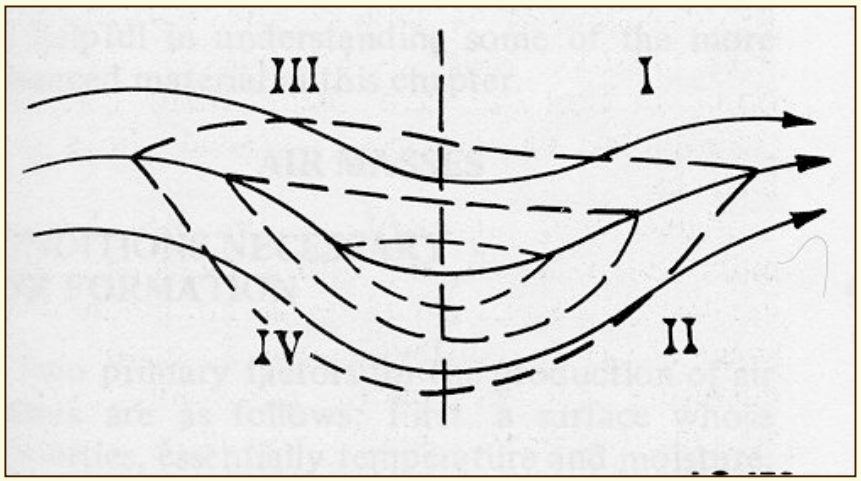
Figure 8-3-9.—Usual position of surface lows in relation to moving jet maxima.

Contour-isotach pattern for shear analysis



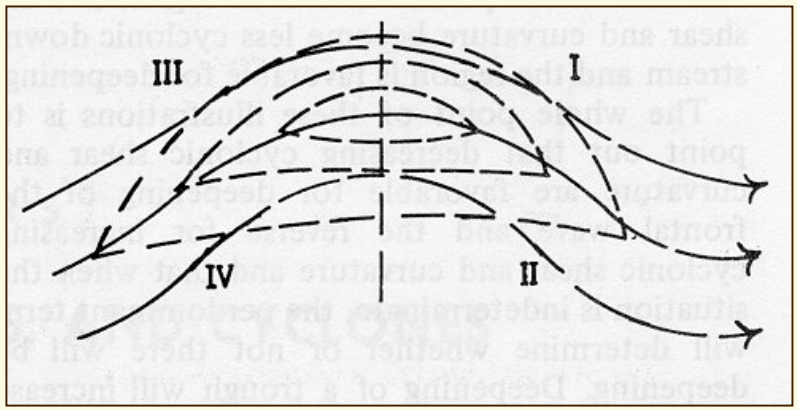
- No curvature of the streamlines
- Shear alone determines the relative vorticity
- Shear downstream in region I and IV becomes less cyclonic
- Shear downstream in region II and III becomes more cyclonic
- Region I and IV favorable for deepening downstream.

Contour-isotach pattern for shear analysis



- In region I, both cyclonic shear and curvature decreases downstream thus highly favorable for deepening.
- In region III, both cyclonic shear and curvature increase downstream thus unfavorable for deepening.
- In region II the cyclonic curvature decreases downstream, but shear increases - situation determined by prominent term.
- In region IV, the cyclonic curvature increase downstream, but cyclonic shear decreases - situation determined by prominent term.

Contour-isotach pattern for shear analysis

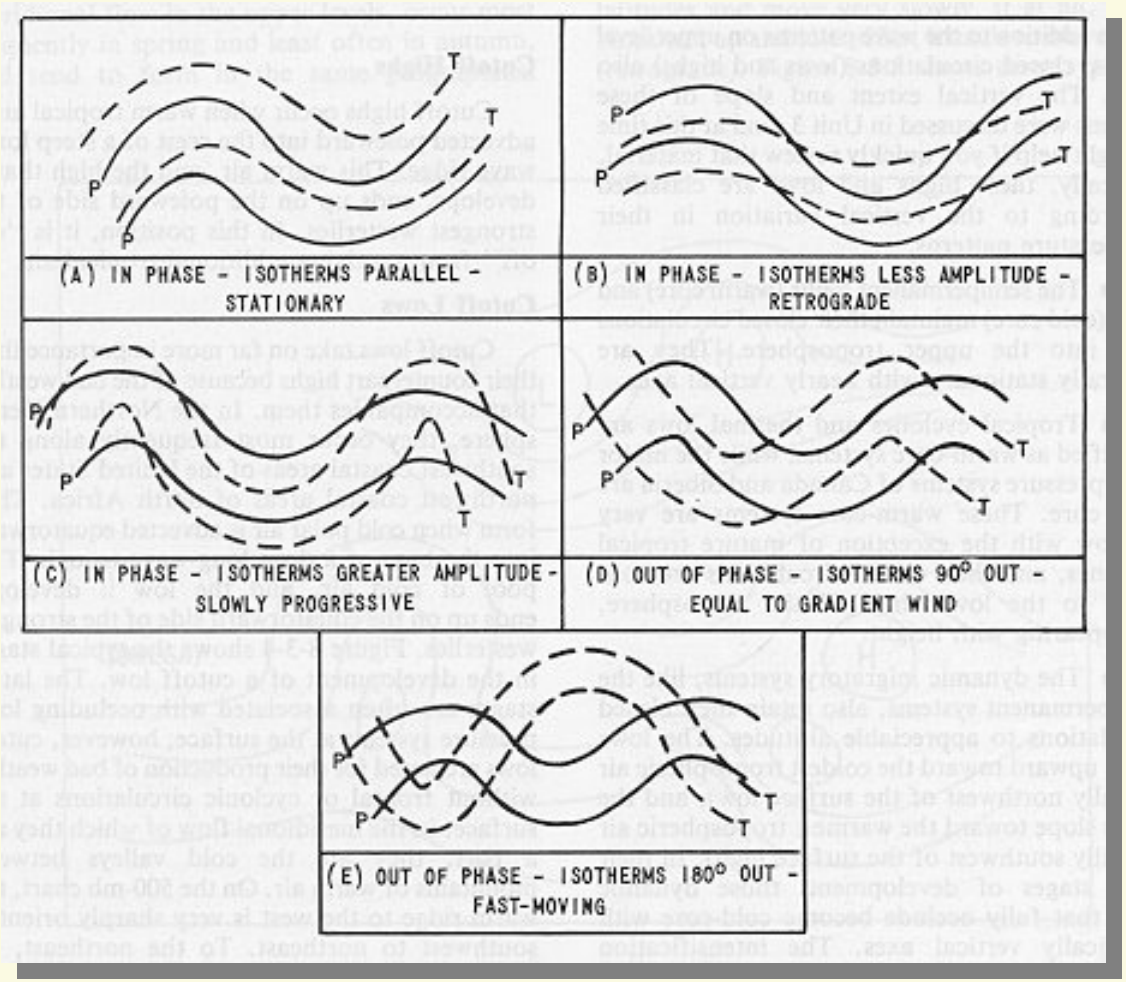


- Region I, cyclonic shear decreases downstream and the cyclonic curvature increases - situation determined by prominent term.
- Region II has increasing cyclonic shear and curvature downstream and is quite unfavorable.
- Region III, the shear becomes more cyclonic downstream and the curvature becomes less cyclonic - situation determined by prominent term.
- Region IV, the shear and curvature becomes less cyclonic downstream and the region is favorable for deepening.

Long and Short Waves

Waves are classified according to their length, amplitude, and speed. Wavelength is the measured distance (in degrees longitude) between successive waves. Measurement taken from trough to trough, ridge to ridge, or from any point on one wave to the same corresponding point on the next wave. The amplitude is measured from the peak of the ridge to the base of the trough. The longer the wave the slower they move.

Isotherm-contour patterns



Long Waves

- ✓ Barotropic/Vary between 50 to 120 deg longitude
- ✓ Outline by the movement of the short waves through the polar front jet
- ✓ They can be progressive, retrogress, or remain quasi-stationary
- ✓ Usually 3-7 in the atmosphere
- ✓ Moves an average of 1 deg per day

Long wave trough contour/isotherm relationship (in phase)

- ✓ Contour and thermal trough same amplitude (barotropic), long wave remains quasi-stationary with no change in amplitude.
- ✓ Thermal trough amplitude greater than contour trough, long wave will progress eastward and fill (CAA ahead of trough and WAA begin).
- ✓ Thermal trough amplitude is less than contour trough, long wave will retrogress (1-2 deg) and deepen (due to WAA ahead of trough and CAA behind).

Short Waves

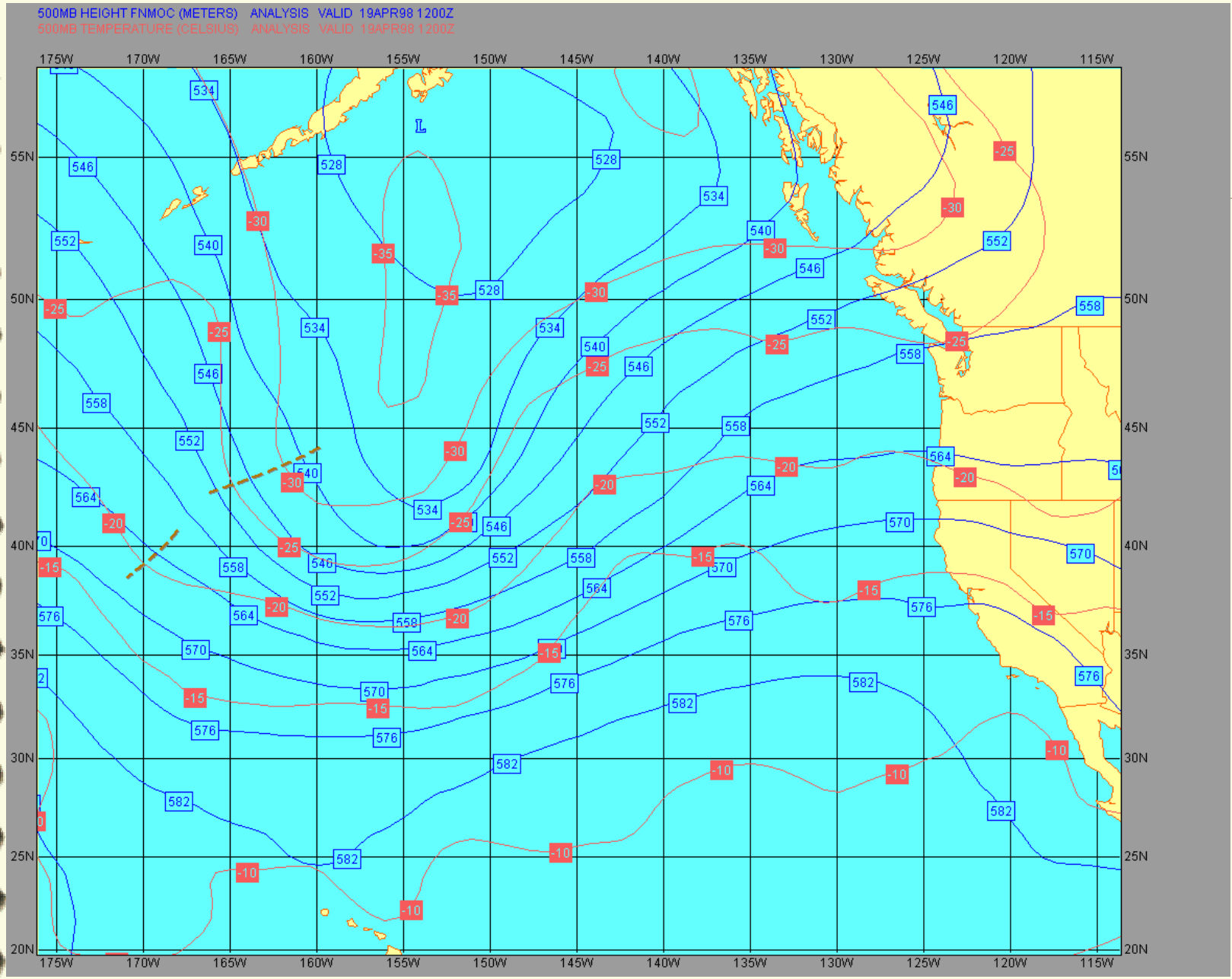
- ✓ Baroclinic
- ✓ CAA into troughs; WAA into ridges
- ✓ Up to 10 major short waves in the northern hemisphere
- ✓ Moves an average of 8 deg per day in the summer and 12 deg per day in the winter
- ✓ Short waves are progressive--never retrogress
- ✓ Height rises to the rear of a short wave trough/advance of short wave ridge.
- ✓ Height falls in advance of short wave trough/to the rear of short wave ridges.

Short wave trough contour/isotherm relationship

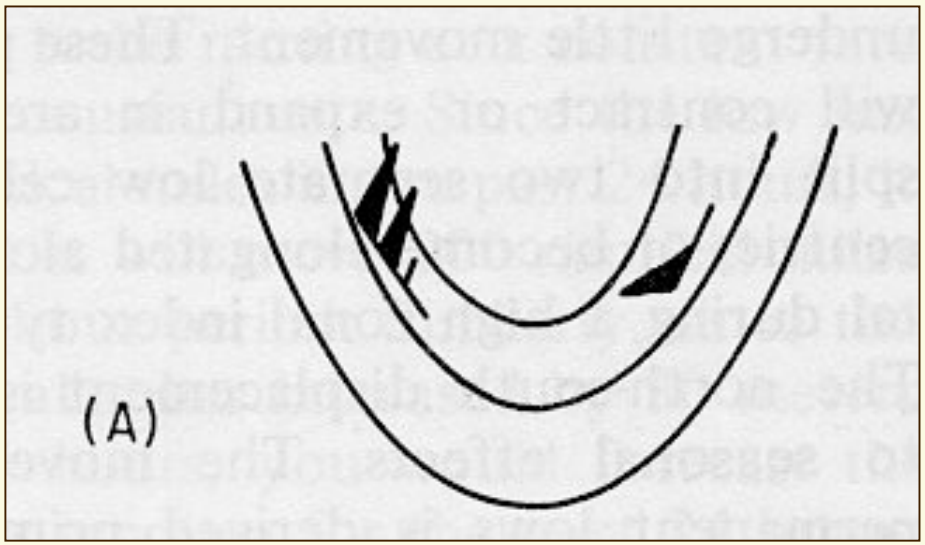
- ✓ Phase relationship tend to remain the same with time.
- ✓ Evaluate temp advection into a trough or ridge from the system axis to the upstream inflexion point.
- ✓ When isotherm/contour are 90 deg out of phase, short wave will move at 50 % of 500mb flow/70% of 700mb flow.
- ✓ When isotherm/contour are 180 deg out of phase, short wave will move rapidly - 70 to 100 % of 700mb flow. Trough will eventually outrun isotherm/contour relationship and fill rapidly.

Guide to moving short waves

- ✓ Move with the long wave pattern.
- ✓ Short waves will intensify/deepen as the move in the long wave trough; fill as they move into long wave ridge.
- ✓ Large amplitude waves generally will move slower than minor short waves.
- ✓ The more out of phase the isotherm/contour relationship, the faster the short wave will move.

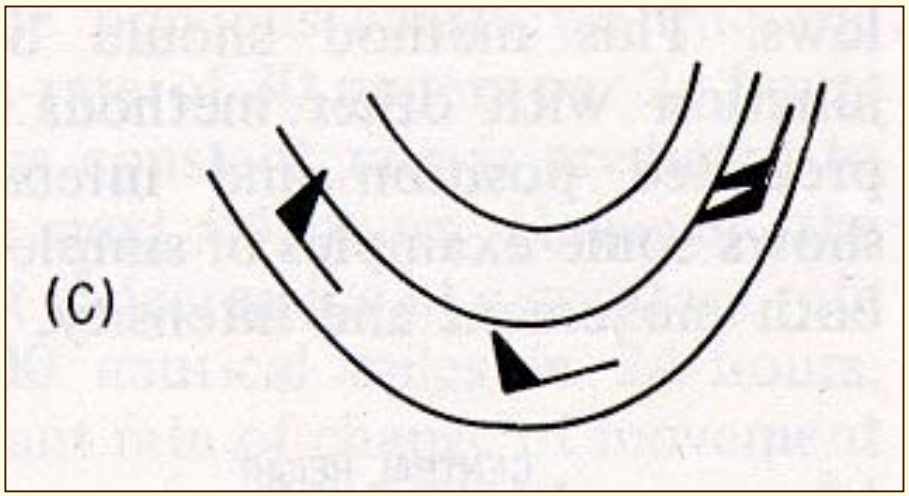

500MB HEIGHT FNMOC (METERS) ANALYSIS VALID 19APR98 1200Z
500MB TEMPERATURE (CELSIUS) ANALYSIS VALID 19APR98 1200Z
175W 170W 165W 160W 155W 150W 145W 140W 135W 130W 125W 120W 115W
55N 50N 45N 40N 35N 30N 25N 20N
L

Effects of super/sub-gradient winds on troughs



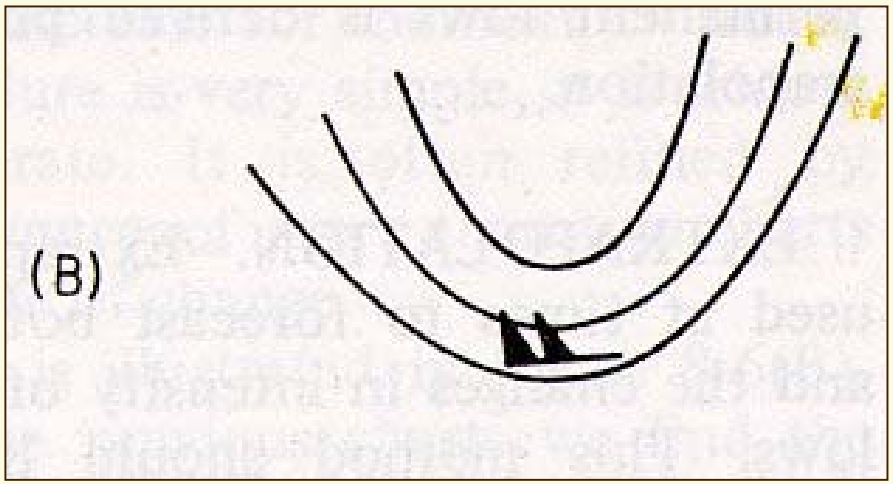
When strongest winds aloft are the North-westerlies on the western side of the trough, the trough deepens.

Effects of super/sub-gradient winds on troughs

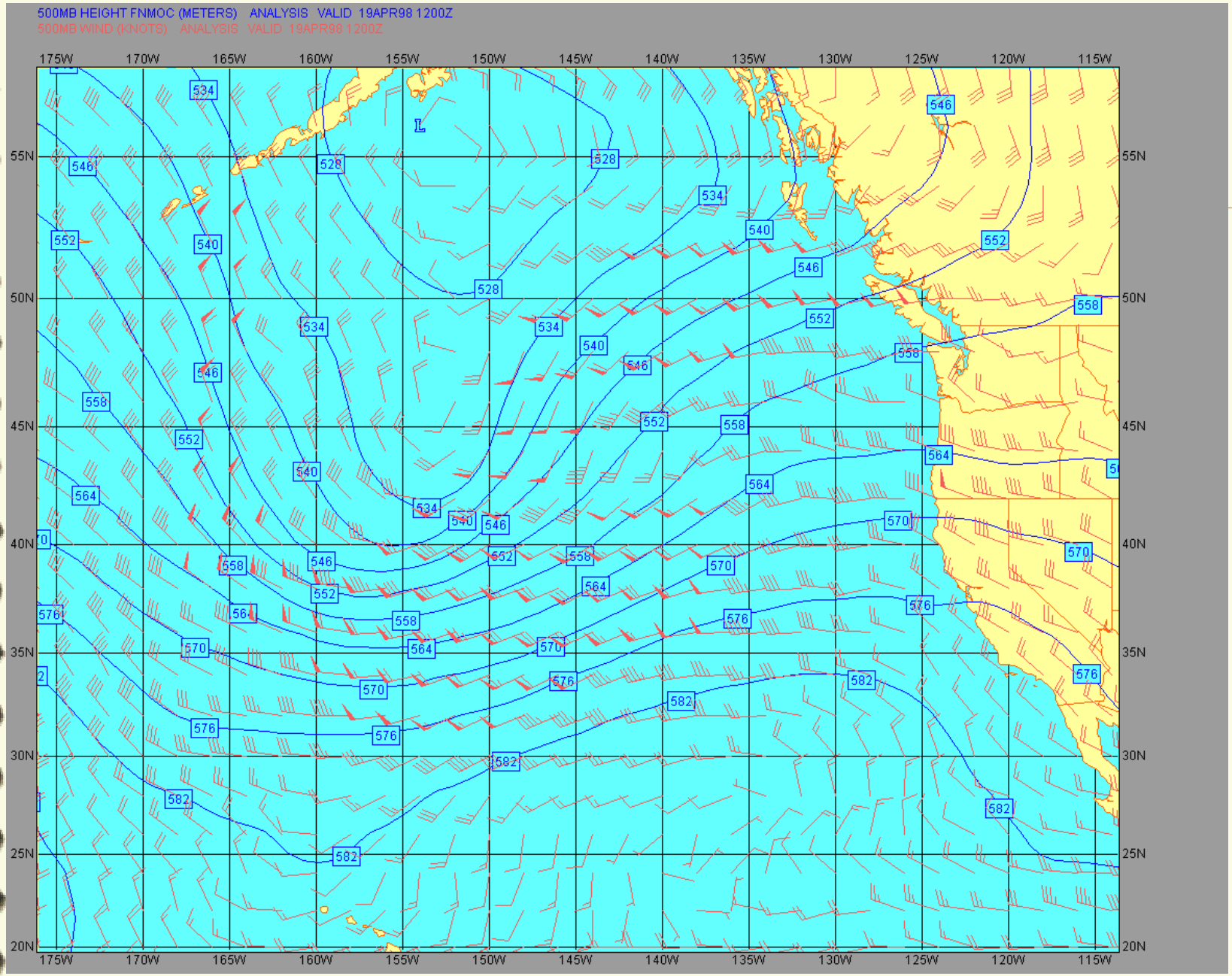


When the strongest winds aloft are the south-westerlies between the trough and the down-stream ridge, the trough decrease in intensity.

Effects of super/sub-gradient winds on troughs



When the strongest winds aloft are the westerlies in the southern quadrant of the trough, the trough moves rapidly eastward and does not change in intensity.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500MB WIND (KNOTS) ANALYSIS VALID 19APR98 1200Z
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125W
120W
115W
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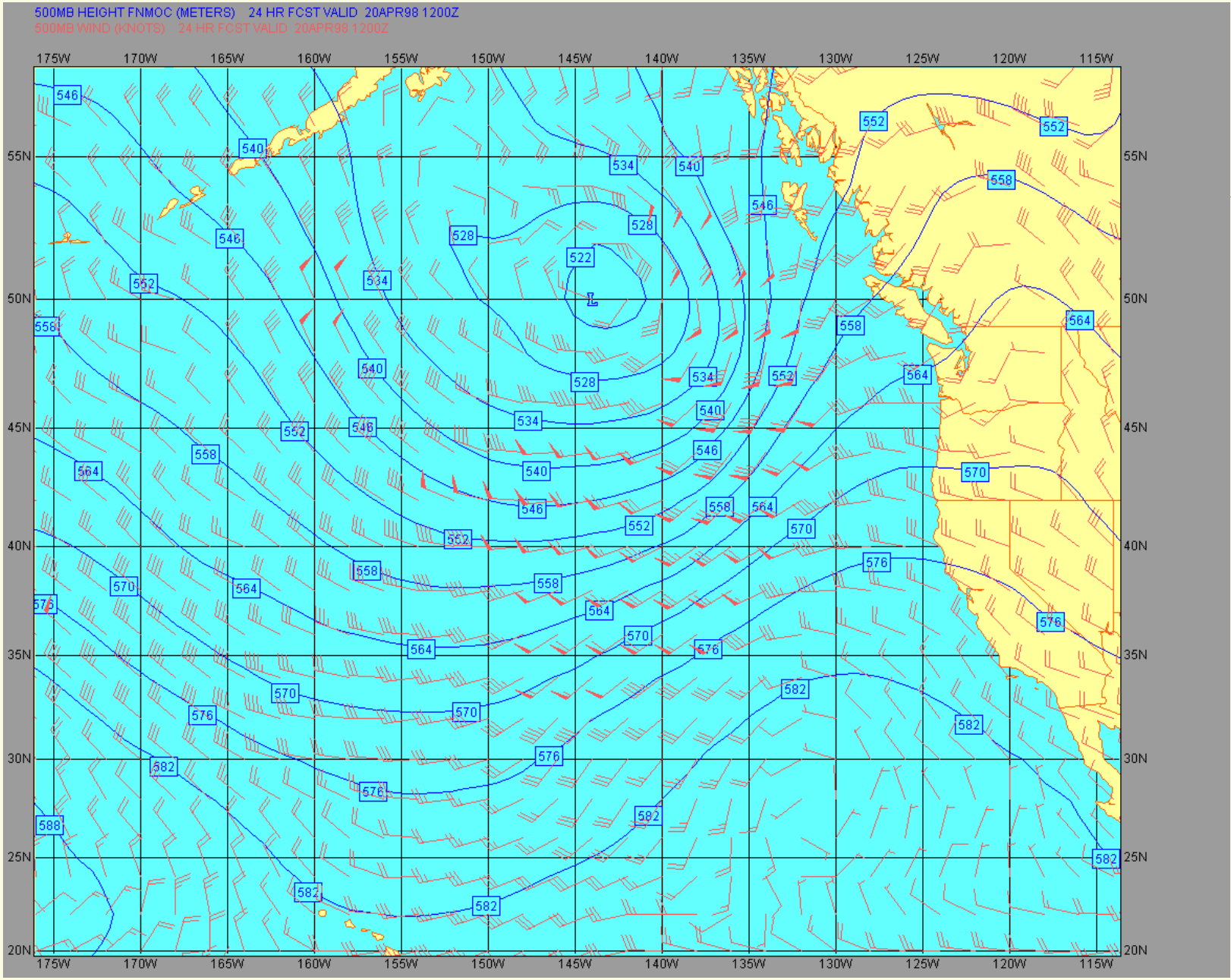
500MB HEIGHT FNMOC (METERS) 24 HR FCST VALID 20APR98 1200Z
500MB WIND (KNOTS) 24 HR FCST VALID 20APR98 1200Z
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165W
160W
155W
150W
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125W
120W
115W
55N
50N
45N
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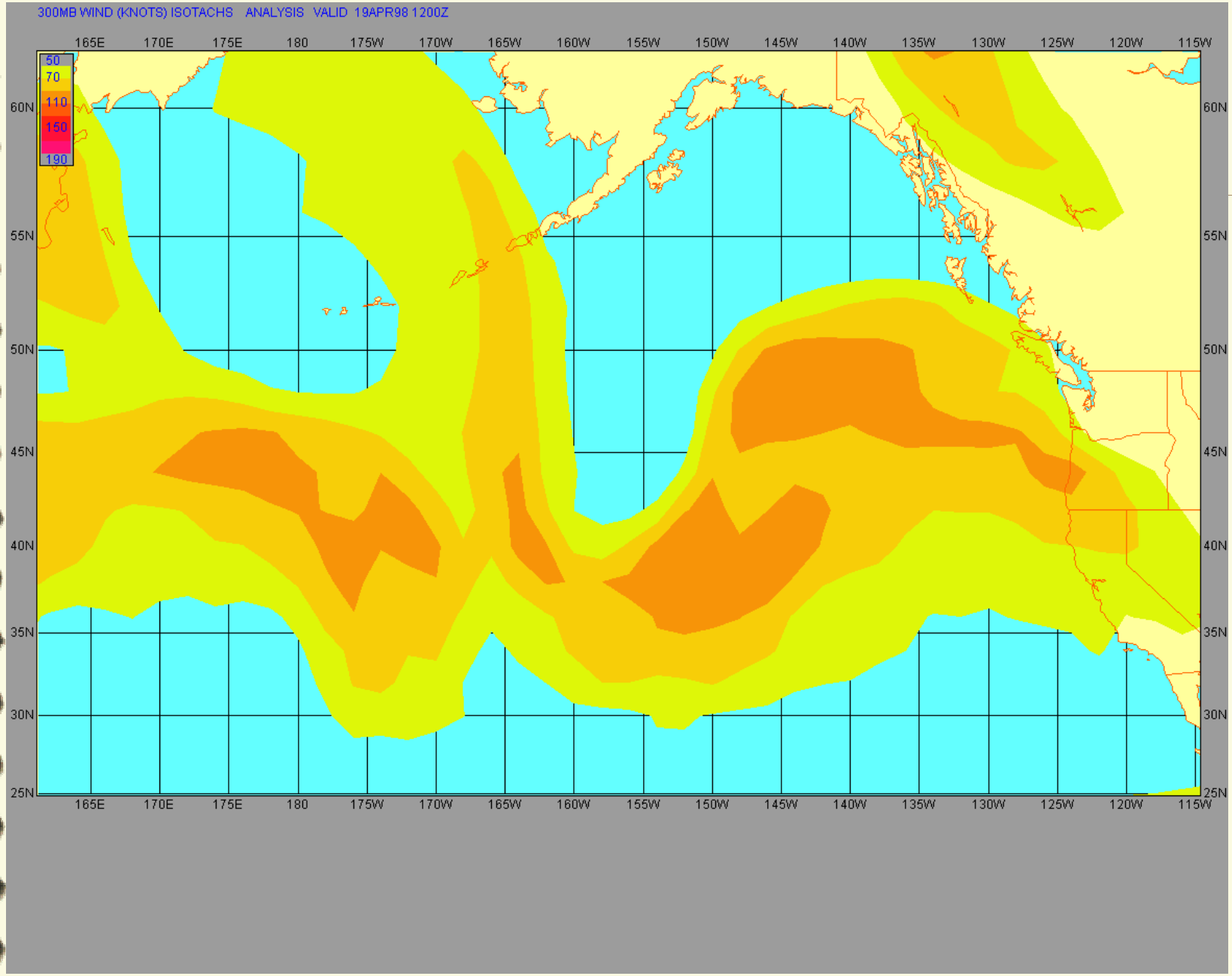
300MB WIND (KNOTS) ISOTACHS ANALYSIS VALID 19APR98 1200Z
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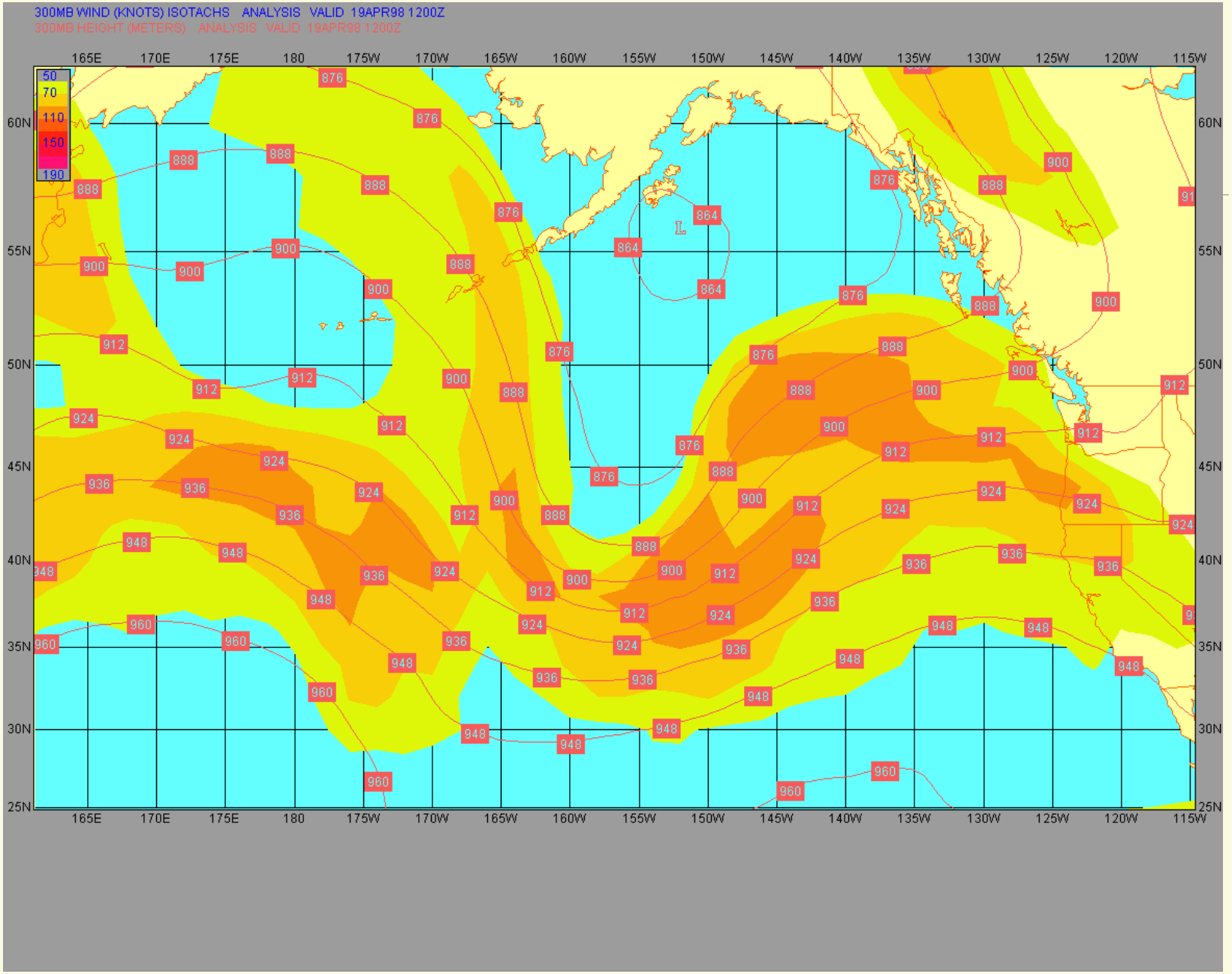
25N


300MB WIND (KNOTS) ISOTACHS ANALYSIS VALID 19APR98 1200Z
300MB HEIGHT (METERS) ANALYSIS VALID 19APR98 1200Z
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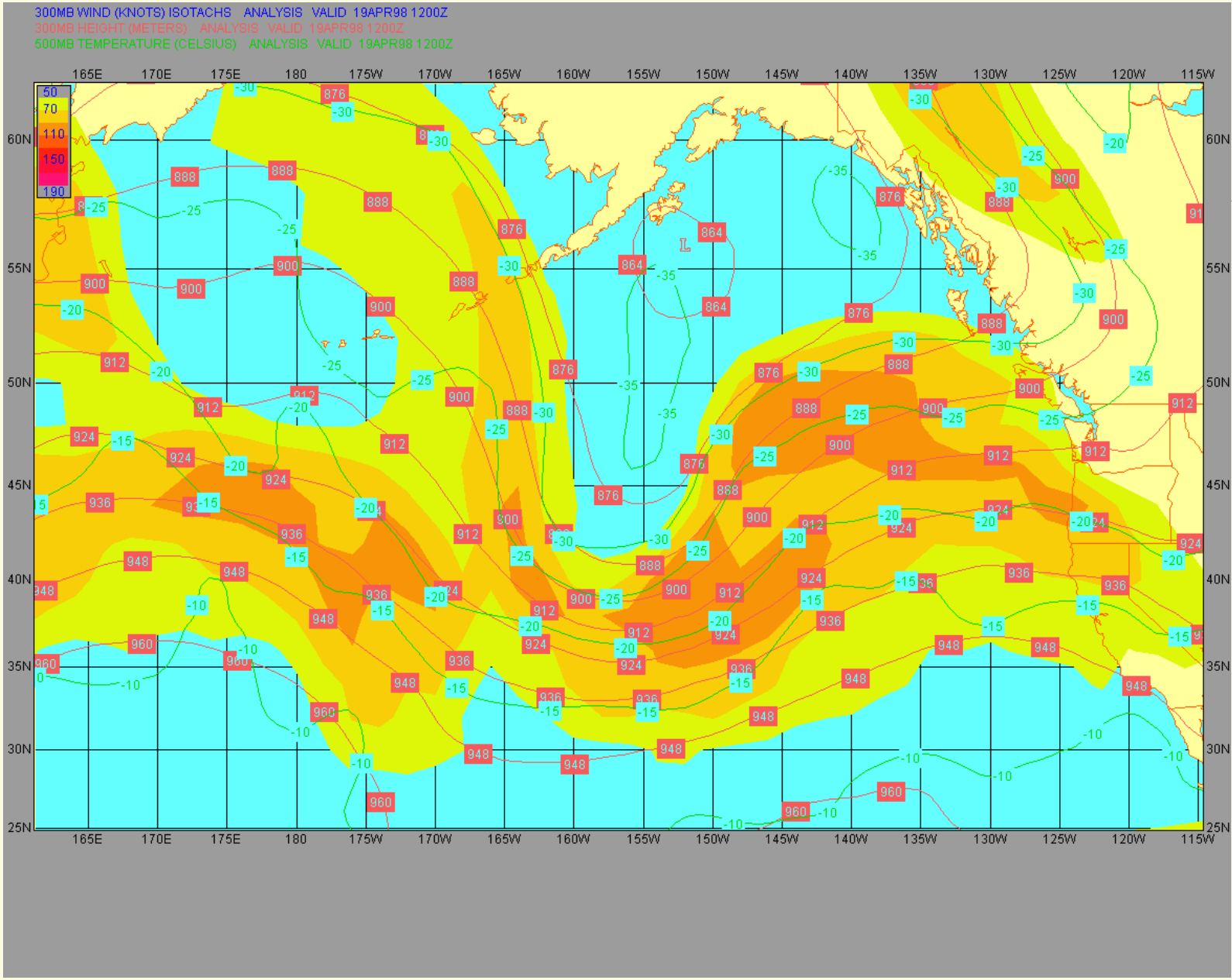
60N 55N 50N 45N 40N 35N 30N 25N


300MB WIND (KNOTS) ISOTACHS ANALYSIS VALID 19APR98 1200Z
300MB HEIGHT (METERS) ANALYSIS VALID 19APR98 1200Z
500MB TEMPERATURE (CELSIUS) ANALYSIS VALID 19APR98 1200Z
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165E 170E 175E 180 175W 170W 165W 160W 155W 150W 145W 140W 135W 130W 125W 120W 115W
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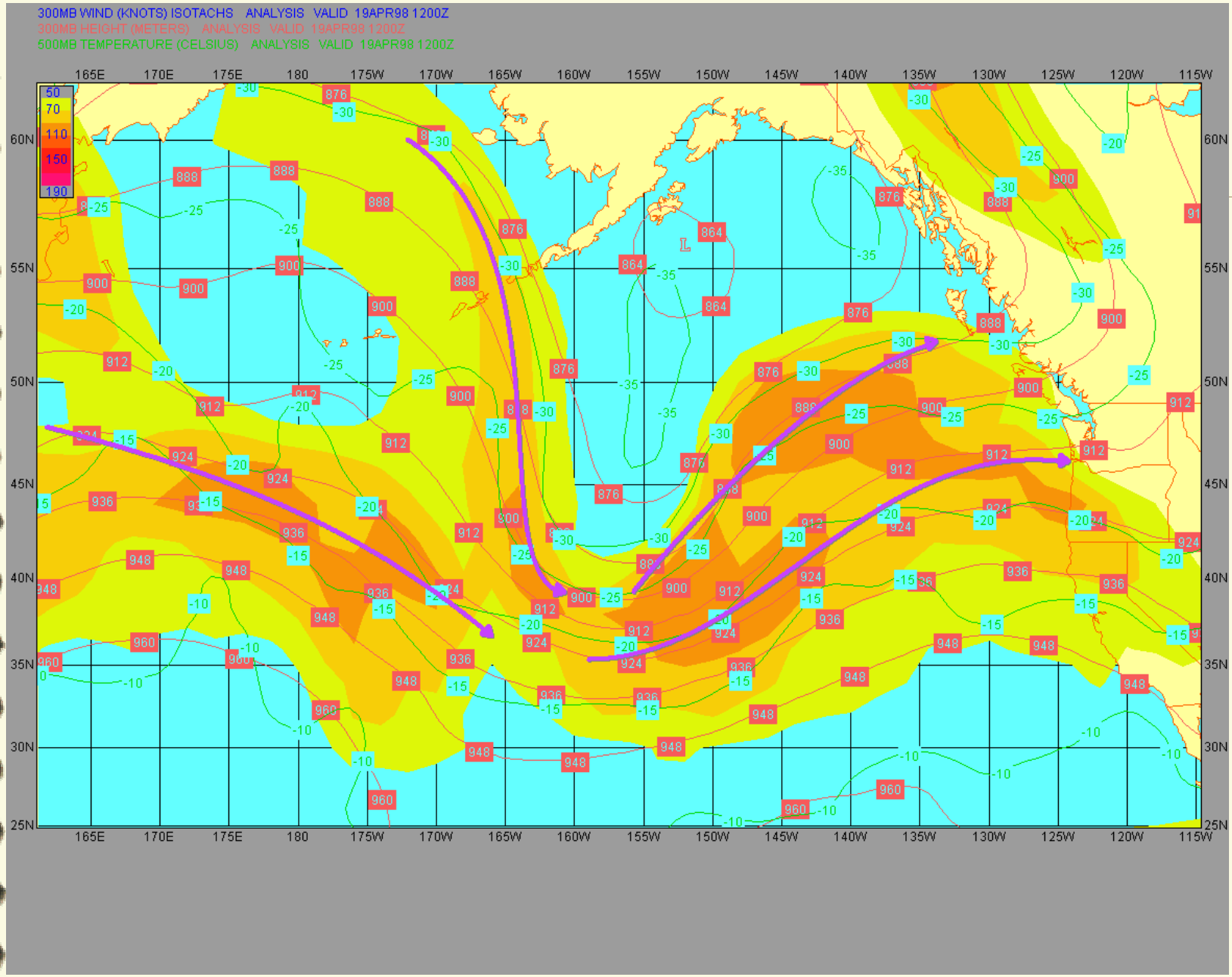
45N
40N
35N
30N
25N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300MB HEIGHT (METERS) ANALYSIS VALID 19APR98 1200Z
500MB TEMPERATURE (CELSIUS) ANALYSIS VALID 19APR98 1200Z
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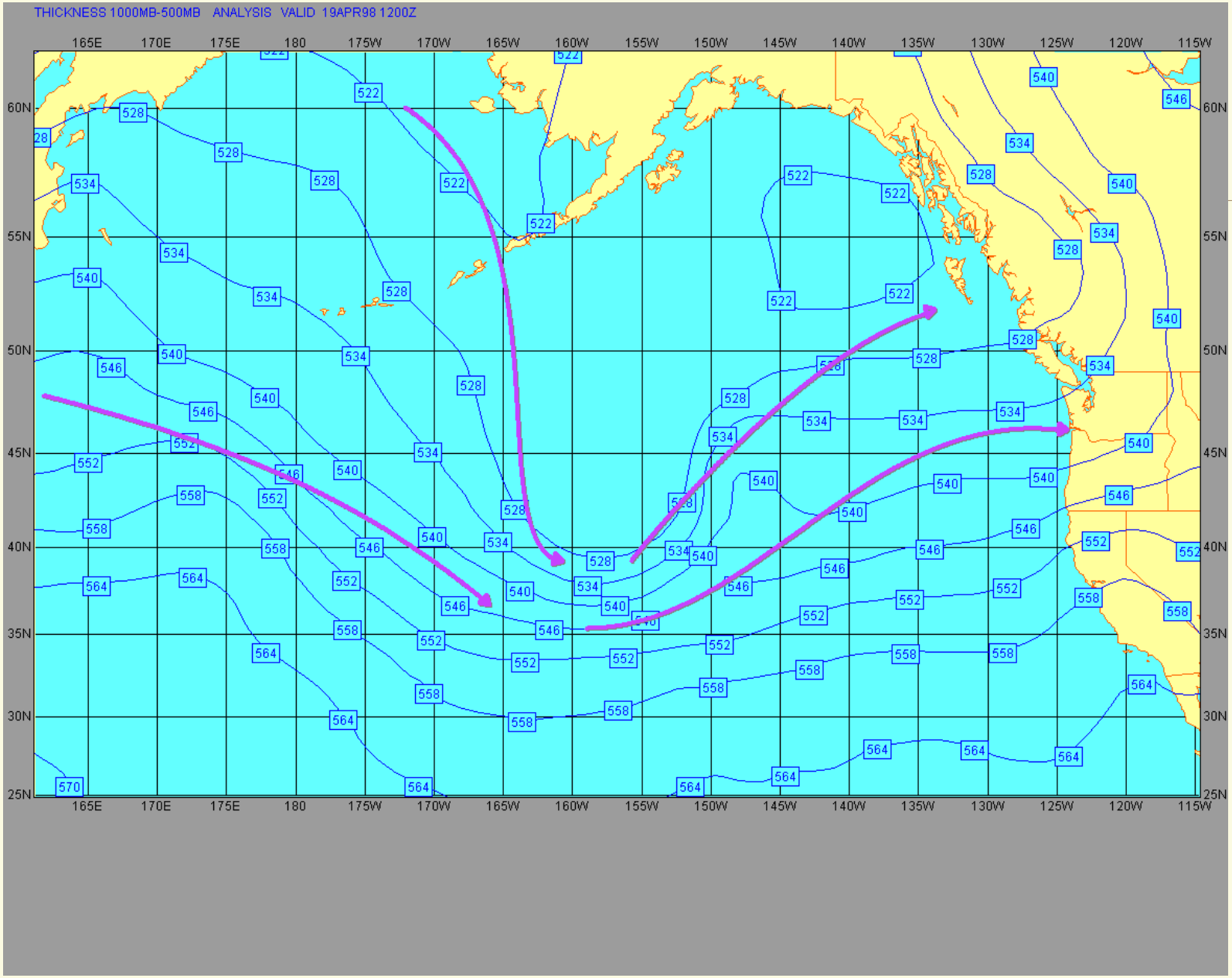
165E 170E 175E 180 175W 170W 165W 160W 155W 150W 145W 140W 135W 130W 125W 120W 115W
60N 55N 50N 45N 40N 35N 30N 25N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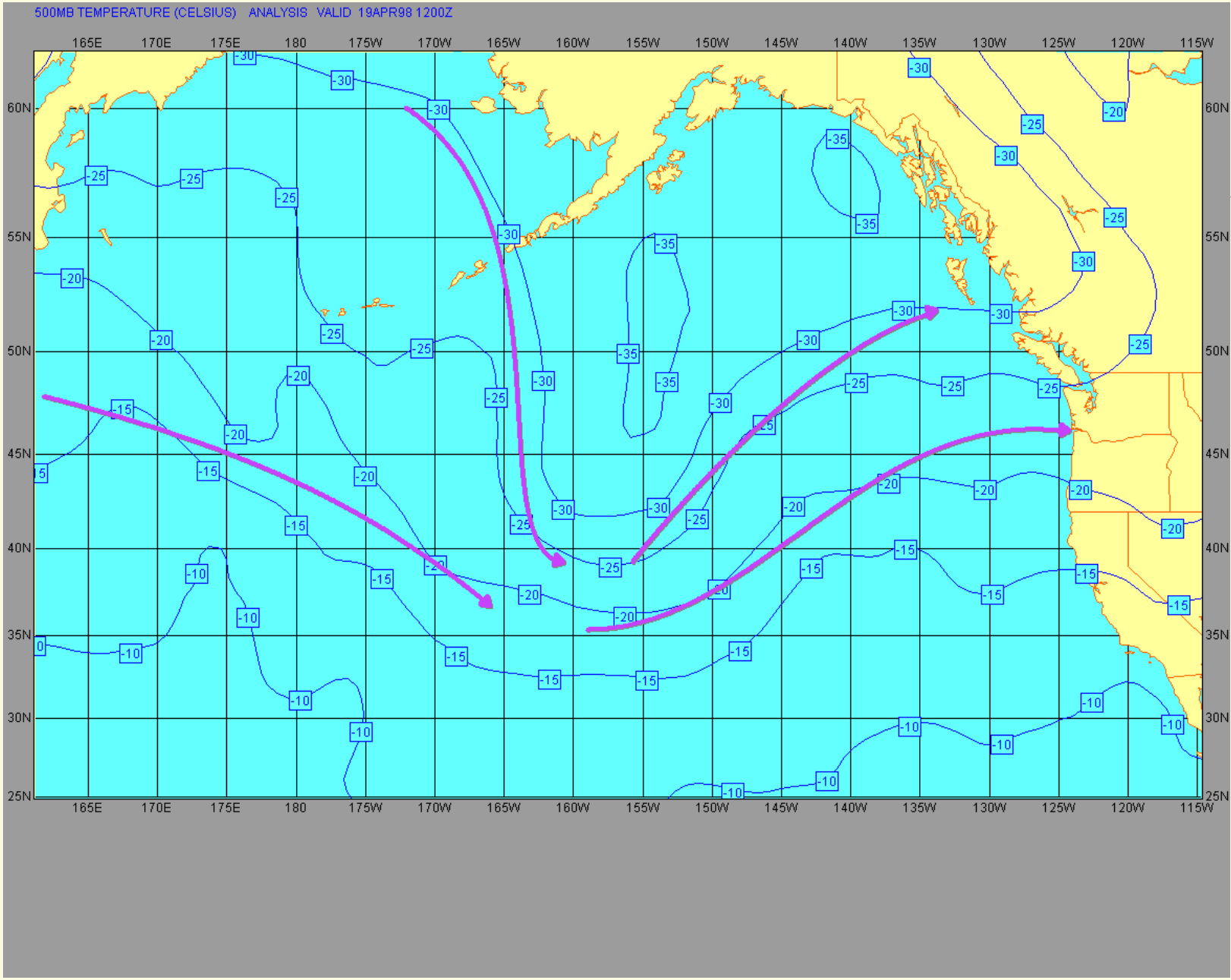
60N 55N 50N 45N 40N 35N 30N 25N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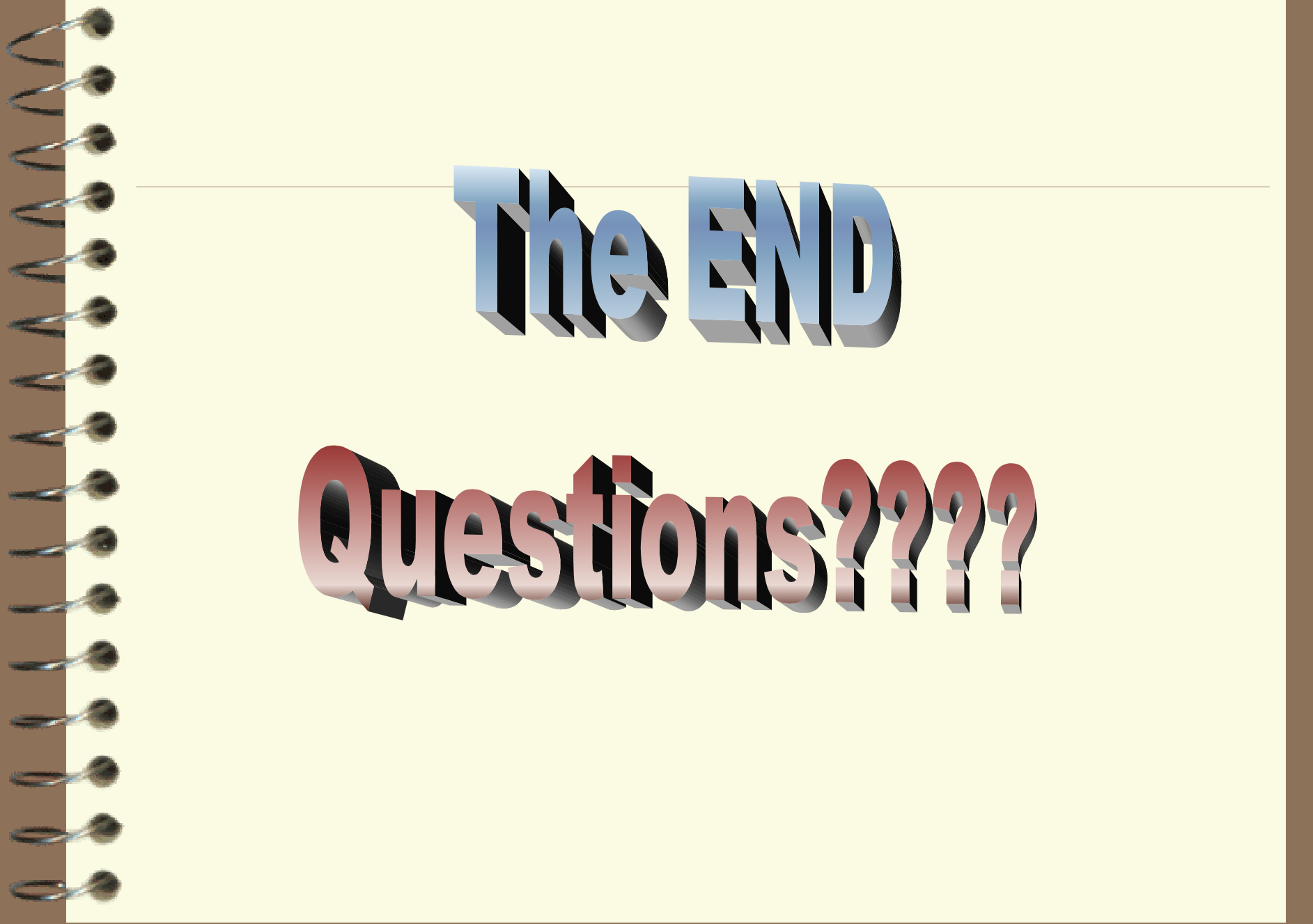
60N 55N 50N 45N 40N 35N 30N 25N


The END
Questions????